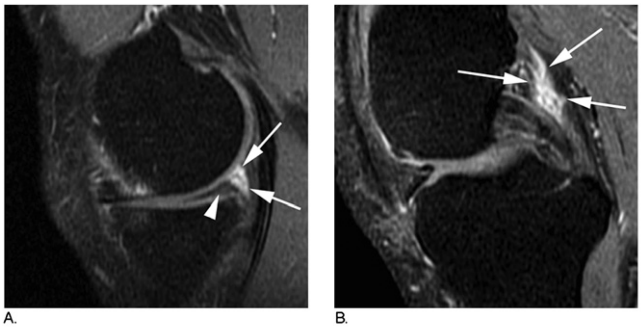

Figure 1. Examples of posterior synovitis. A. Horizontal medial posterior horn meniscal tear (arrowhead) and marked (grade 2) surrounding perimeniscal synovitis (arrows). B. Marked synovitis posterior to the posterior cruciate ligament (arrows).

414
MORPHOLOGICAL MEASURES OF FEMUR AND PELVIS ON PLAIN RADIOGRAPHS AS RISK FOR HIP OSTEOARTHRITIS

H. Abdulrahim [1], S. Doherty [1], K. Muir [2], R. Maciewiecz [3], K. Sehat [1], W. Zhang [1], M. Doherty [1]. [1] *Univ. of Nottingham, Nottingham, United Kingdom;* [2] *Univ. of Warwick, Coventry, United Kingdom;* [3] *AstraZeneca, Mölndal, Sweden*

Purpose: Variation in morphology in the proximal femur and pelvis (e.g. acetabular dysplasia, non-spherical femoral head) can biomechanically compromise the hip joint and predispose to osteoarthritis (OA). Such morphological variation may in part explain the heritability of hip OA. The objective of this study was to evaluate a range of 2-dimensional morphological measures on standard radiographs to determine: [1] normal range, right: left symmetry, age and gender differences; and [2] whether they are independent risk factors for hip OA.

Method: A nested case control study was undertaken in 566 unilateral hip OA cases and 1108 controls in the established Nottingham Genetics of Osteoarthritis and Lifestyle (GOAL) database. Unaffected hips of hip OA cases were compared to the same side hips of controls. We assumed that the unaffected hip values in cases reflect the original measures on the affected side prior to development of OA. Definition of radiographic hip OA was joint space width (JSW) $\leq$ 2.5 mm. Standardized antero-posterior radiographs of pelvis were used to measure 10 morphological features (Table 1). The measurements were performed by single observer and the reproducibility was evaluated at baseline, mid and end of the study. Normal values, thresholds (mean$\pm$1.96SD) and symmetry of the features were derived from the control subjects. The intra-observer reliability and symmetry between right and left hip were examined using intra-class correlation coefficient (ICC). The relative risk of hip OA associated with each measure was estimated using odds ratio (OR) and 95% confidence interval (CI). Logistic regression was used to adjust for age, gender and body mass index (BMI). Measurements were divided into tertiles to examine dose response.

Results: The ICC for intra-observer reliability was very good for all the measurements (ICC >0.84). In controls all morphological measures were symmetrical between right and left (ICC ranged from 0.80-0.95). Men had greater measures than women, except for neck shaft angle which was bigger in women. Age and BMI were associated with some but not all measures, whereas height was positively associated with all apart from sourcil angle and neck shaft angle.

Between cases and controls, smaller femoral head diameter, neck length, outer shaft diameter, inner shaft diameter and pelvic width were associated with greater risk of hip OA, whereas a larger sourcil angle was associated with increased risk of hip OA (Table 1). The measures with no dose response were re-analysed using tertile 2 as a reference under the assumption of either small or large measures would increase the risk of hip OA - the U curve relationship. However, we did not find any significant U curve association based on the tertile, but the thresholds of mean$\pm$ 1.96SD, where either lower or higher neck shaft angle was a risk factor of hip OA (Fig 1).

Conclusion: All morphological measurements are symmetrical between right and left hips but, as expected, differ between men and women. Several variations in morphology of femoral and pelvic bones that are easily measurable on standard radiographs appear to be risk factors for hip OA. The risk increases as femoral head diameter, neck length, outer shaft diameter, inner shaft diameter and pelvic width decrease and as sourcil angle increase, whereas both extremes of neck shaft angle confer risk. Prospective studies are required to confirm these findings.

Table 1: Morphological features and the risk of hip OA

	Odds ratio (95% confidence interval)			
	Tertile 1	Tertile 2	Tertile 3	p trend
Head diameter (HD)	1	0.53 (0.38-0.74)	0.32 (0.18-0.59)	0.001
Neck width (NW)	1	0.88 (0.64-1.23)	1.01 (0.54-1.89)	0.239
Neck length (NL)	1	0.76 (0.58-0.99)	0.63 (0.48-0.83)	0.001
Outer shaft diameter (OSD)	1	0.64 (0.47- 0.86)	0.50 (0.35- 0.71)	<0.001
Inner shaft diameter (ISD)	1	0.71 (0.55- 0.93)	0.38 (0.28-0.51)	<0.001
Mid-centre distance (MCD)	1	0.92 (0.69-1.19)	1.33 (1.03-1.73)	0.023
Sourcil angle (SA)	1	2.06 (1.52-2.79)	6.86 (5.09-9.26)	<0.001
Neck shaft angle (NSA)	1	0.78 (0.60-1.02)	0.93(0.72-1.22)	0.606
Pelvic width (PW)	1	0.63 (0.48-0.84)	0.57 (0.43-0.76)	<0.001
Pelvic height (PH)	1	0.67 (0.49-0.93)	0.74 (0.49-1.12)	0.05

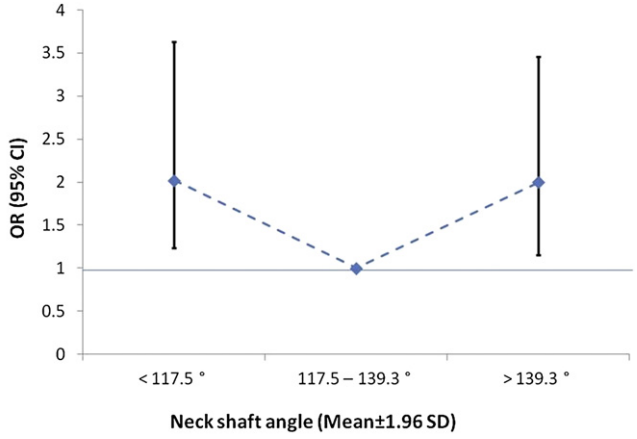

Figure 1 : Neck shaft angle (NSA) and risk of hip OA

415
THE ASSOCIATION OF MRI-DETECTED SUBCHONDRAL BONE MARROW SCLEROSIS WITH CARTILAGE LOSS IN A COHORT OF SUBJECTS WITH KNEE PAIN.

M.D. Crema [1], J. Cibere [2], E.C. Sayre [2], F.W. Roemer [1], H. Wong [2], A. Thorne [2], J. Singer [2], J.M. Esdaile [2], J.A. Kopec [2], S. Nicolaou [2], M.D. Marra [1], A. Guermazi [1]. [1] *Boston Univ., Boston, MA, USA;* [2] *Univ. of British Columbia, Vancouver, BC, Canada*

Purpose: The role of subchondral bone marrow edema-like lesions (BMLs) for incidence and progression of adjacent cartilage damage in subjects with or at risk for knee osteoarthritis (OA) is well known, but little information is available regarding the role of subchondral bone marrow sclerosis (SS) in regard to adjacent cartilage, independently of the presence of edema-like BMLs. Histologically, BMLs and SS exhibit similar features including trabecular bone abnormalities, fibrosis and necrosis. Thus, the aim of this study was to assess the association of magnetic resonance imaging (MRI)-detected subchondral sclerosis with cartilage loss over time in the same region of the knee in a cohort of subjects with knee pain.

Methods: A population-based sample 163 subjects (1 knee per subject) with knee pain participated in a longitudinal study to assess knee osteoarthritis progression (KOAP study). Subjects received baseline knee

radiographs as well as baseline and 3-year follow-up MRI examinations. Sagittal oblique T1-weighted fast spin echo, sagittal source 3D T1-weighted fat-suppressed (FS) spoiled gradient recalled echo with reformation performed in the axial and coronal planes, and sagittal and coronal T2-weighted FS fast spin echo sequences were acquired at baseline and follow-up. The knee was divided in 6 regions: patella, trochlea, medial femur, lateral femur, medial tibia, and lateral tibia. Baseline MRI-detected SS, defined as low-signal intensity abnormalities in the subchondral bone in both T1-weighted and T2-weighted sequences, were graded in each region of the knee from 0 to 3. The presence of baseline SS is considered as grades $\geq$ 1. The absence of baseline SS (grade 0) is considered as the reference group. Cartilage morphology was assessed in each region of the knee from 0 to 4. Grades 0 (normal) and 1 (intrasubstance signal changes) represent normal cartilage morphology. Any increase of cartilage grade from baseline to follow-up was considered as cartilage loss, except the increase from grade 0 to 1. Regions having stable or decreasing cartilage scores from baseline to follow-up were used as the reference for the analysis. Each region of the knee was assessed separately (regional analysis). The association of baseline SS (grades $\geq$ 1) with cartilage loss over time in the same region of the knee was assessed using logistic regression, adjusted for baseline age, gender, BMI, and Kellgren-Lawrence grade in the first model, and with the addition of presence at baseline of concomitant edema-like BMLs in a second model. We also assessed the correlation between radiographic SS and MRI-detected SS in the three compartments of the knee using Spearman's rank correlation.

Results: From the 163 subjects included, 88 (54%) were female and 64 (39.3%) had baseline radiographic OA (Kellgren-Lawrence grade $\geq$ 2). The prevalence of baseline MRI-detected SS in regions varied between 1.6% at the trochlea and 17% at the medial tibia. The occurrence of cartilage loss over time in regions varied between 6.0% at the lateral tibia and 13.1% at the medial femur. The prevalence of baseline SS on radiographs varied between 2.9% at the patellofemoral compartment and 14.2% at the medial tibiofemoral compartment. In both adjusted models we found no significant association between baseline MRI-detected SS and cartilage loss over time in the same region of the knee. Moderate and significant correlations were found between MRI-detected and radiographic-detected SS at the medial tibiofemoral (0.58; $p<0.001$) and lateral tibiofemoral (0.61; $p<0.001$) compartments. In the patellofemoral compartment, correlation was 0.26 ($p<0.001$).

Conclusion: Subchondral sclerosis was not associated with an increased risk of cartilage loss in the same knee region at the 3 years follow-up visit. The role of subchondral sclerosis in regard to structural disease progression in the knee using cartilage as the outcome needs to be questioned.

416

LONGITUDINAL CHANGES IN CARTILAGE THICKNESS IN KNEES WITH OSTEOPHYTES BUT NO JOINT SPACE NARROWING VERSUS CONTRALATERAL KNEES WITHOUT RADIOGRAPHIC OA

S. Cotofana [1,2], R. Buck [3], D. Dreher [4], W. Wirth [1,2], F. Roemer [5,6], J. Duryea [7], M. Nevitt [8], F. Eckstein [1,2]. [1] *PMU-Salzburg, Salzburg, Austria;* [2] *Chondrometrics GmbH, Ainring, Germany;* [3] *StatAnswers Consulting LLC, Minneapolis, MN, USA;* [4] *Totzke & Dreher Scientific SA, Geneva, Switzerland;* [5] *Dept. of Radiology, Boston, MA, USA;* [6] *Boston Core Imaging Lab, Boston, MA, USA;* [7] *Harvard Univ., Boston, MA, USA;* [8] *OAI Coordinating Ctr., San Francisco, CA, USA*

Purpose: Cartilage loss is considered a hallmark of osteoarthritis (OA). However, recent evidence from 3D MRI morphometric measurements suggests that knee cartilage may undergo thickening (swelling or hypertrophy) post-traumatically and at early (radiographic) stages of human knee OA. Increasing cartilage thickness in early OA knees has been particularly observed in the external medial and lateral subregions of the weight-bearing femur (ecMF and ecLF). Spatial and directional heterogeneity in longitudinal cartilage thickness change, however, complicate estimates of disease progression, because it increases the variability of the outcome measure. We have shown previously that cartilage thickness in ecMF and ecLF (but not in other femorotibial subregions) is significantly thicker in knees with osteophytes (OPs) and no joint space narrowing (JSN) than in contralateral knees without OPs and without JSN. We test the hypothesis that cartilage thickness displays significant longitudinal (one year) thickening and is more variable in ecMF and ecLF in OP knees without JSN, compared with contralateral knees without signs of radiographic OA.

Methods: A within-person, between-knee approach was used to assess longitudinal change of subregional cartilage thickness. Of 4798 Osteoarthritis Initiative participants, 50 were identified who a) displayed definite femorotibial OPs and no JSN in one knee, b) showed OP and JSN scores of zero in the contralateral knee, and c) had baseline and one year follow-up images available on both knees (BMI 27.7 (4.7); age 61.1 (9.7); 25 women). Cartilage thickness change and its variability were measured longitudinally in femorotibial subregions, using a sagittal DESSwe MRI sequence. Location-specific joint space width (JSW) from fixed flexion radiographs was determined using dedicated software. One year changes in ecMF and ecLF were selected as primary endpoints, and change in other subregions or JSW measures as exploratory endpoints. Location-specific associations of OPs with cartilage thickness were evaluated using paired t-tests and mixed effect models.

Results: Longitudinal cartilage thickness change in ecMF was -6$\pm$94μm in OP knees vs. -1$\pm$68μm in non-OP knees; the difference was not statistically significant ($p=0.78$). The change in ecLF was +18$\pm$91μm in OP vs. +4$\pm$76μm in non-OP knees ($p=0.38$). Significant differences in cartilage thickness change were detected in the central lateral tibia (-49$\pm$108μm in OP vs. +13$\pm$95μm in non-OP knees; $p=0.001$); this finding remained statistically significant after correction for multiple testing of 16 subregions. No significant differences in JSW change were identified between OP and non-OP knees. In OP knees, the standard deviation of longitudinal thickness change was larger than in non-OP knees in 12 of 16 subregions. This finding reached statistical significance in the central and anterior medial tibia and in ecMF ($p<0.05$) and remained significant in the anterior medial tibia after adjusting for multiple comparisons.

Conclusion: These results indicate that variability of longitudinal cartilage thickness change is larger in knees with early radiographic OA (e.g. both thinning and thickening potentially going on at the same time) than in contralateral knees without signs of radiographic OA. OP knees displayed significantly greater cartilage loss in the central lateral tibia, but did not show evidence of longitudinal thickening compared with contralateral non-OP knees.

417

CAN T2 RELAXATION BE USED TO PREDICT KOOS OTHER SYMPTOMS? - DATA FROM THE OSTEOARTHRITIS INITIATIVE

A. Martinez-Torteya [1], J.I. Galván-Tejada [1], S. Totterman [2], J. Farber [2], V. Treviño [1], J.G. Tamez-Pena [1]. [1] *ITESM, Monterrey, Nuevo Leon, Mexico;* [2] *Qmetrics Technologies, Rochester, NY, USA*

Purpose: The development of targeted therapies for OA related knee pain requires an understanding of the precise etiology, the source, of the pain. MRI derived T2 relaxations maps may provide a non-invasive tool capable of localizing OA related knee pain. But, due the heterogeneity of the T2 values in the different joint structures at the different stages of the OA, the analysis of the T2 maps can be very complex. The analysis can be simplified by using advanced bioinformatics tools that can automatically explore the association of thousands of quantitative image findings to knee symptoms. The purpose of this work was to study a) the use of advanced image analysis tools to automatically quantitate T2 based image variables b) whether those variables can predict OA related knee pain as measured by KOOS other symptoms score.

Methods: Osteoarthritis Initiative clinical datasets releases 0.2.2 and 3.2.1 and 0.C.2 and 3.C.1 image datasets were used in this study. The 149 subjects with baseline right knee multi-echo spine echo (MESE) and 3D WE DESS MR image series were included into the study. The 3D WE DESS images were segmented using iPAS (IMITEK, Monterrey, Mexico) and the segmented image sets were co-registered with the corresponding MESE image series. T2 relaxation time was then computed for every voxel in the images. After the T2 computation, 520 T2 variables were extracted from 12 anatomical locations of the tibia-femoral joint. The subjects were divided into three categories: subjects experiencing many symptoms (MS) (KOOS<70), subjects having few or no symptoms (NS) (KOOS>90), and subjects with moderate symptoms (70<=KOOS<=90). GALGO software was used to automatically find the top variables that best separate the 44